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10-6-1967

### Service Propulsion System (SPS) - Malfunction Symptoms 1 - 10 hand drawn diagrams

National Aeronautics and Space Administration (NASA)

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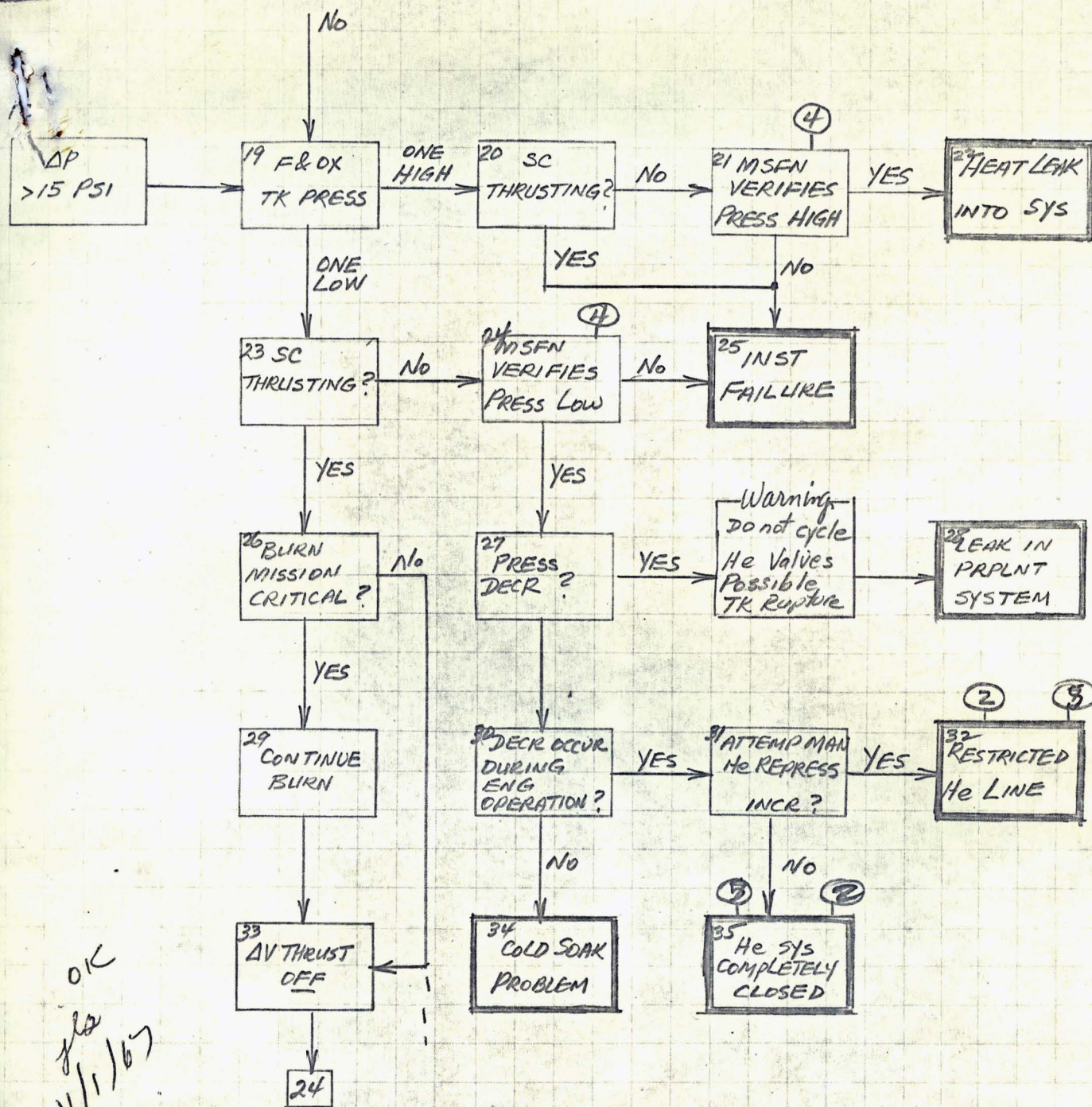
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④ CAUTION - ΔP between F&OX TK-PRESS should not exceed 15 PSI during a burn. Degraded performance, rough combustion, and/or engine failure may result.

② system operable until SPS Pc is < TBD psia. Engine chugging may occur.

⑦ All subsequent SPS burns should be made with SPS He VLVs OFF to minimize ΔP between F&OX.

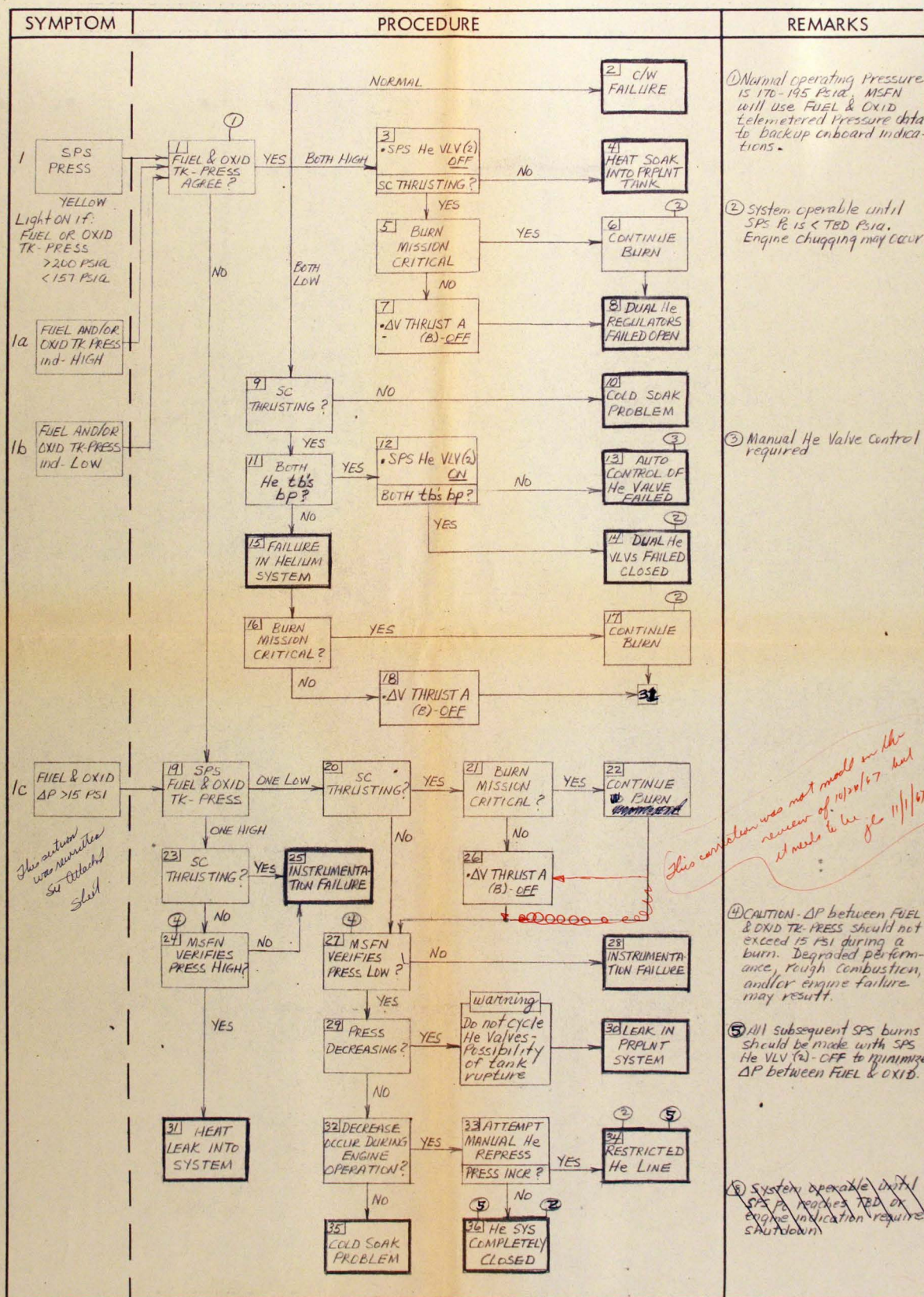
⑧ system operable until SPS pc, or engine indication requires shutdown.



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re changes

ACTION ITEMS  
LAST PAGE  
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# APOLLO OPERATIONS HANDBOOK



G&N  
MALFUNCTION

SCS  
MALFUNCTION

SPS  
MALFUNCTION

RCS  
MALFUNCTION

EPS  
MALFUNCTION

T/C  
MALFUNCTION

ECS  
MALFUNCTION

SEQ  
MALFUNCTION



# APOLLO OPERATIONS HANDBOOK

SYMPTOM	PROCEDURE	REMARKS
<p>2 SPS ROUGH ECO</p> <p>YELLOW</p> <p>Light ON if: Vibration level of 180 g's Peak-to-Peak for 70-120 msec, or 360 g's Peak-to-Peak for 30-70 msec.</p>	<p>1 BURN MISSION CRITICAL?</p> <p>YES → 2 FCSM-SPS A &amp; B - RESET/OVERRIDE FCSM-SPS A &amp; B - SPSA &amp; SPSB SC CONTROL MODE?</p> <p>NO → 3 ΔV THRUST-A (B) - CEF ROUGH ECO ON?</p> <p>YES → 4 C/W FAILURE</p> <p>NO → 5 MSFN VERIFIES SPS ABNORMAL OPERATION</p> <p>YES → 6 SPS COMBUSTION INSTABILITY</p> <p>NO → 7 POSSIBLE COMBUSTION INSTABILITY OR INSTRUMENTATION FAILURE</p> <p>8 FCSM-SPS A &amp; B - RESET/OVERRIDE SC CONT MODE?</p> <p>SCS OR TAC CW → 9 ΔV TRANSLATION OR DIRECT LILLAGE THRUST ON PB - Push</p> <p>G/N → 10 CONTINUE NORMAL PROCEDURES</p> <p>11 Automatic Restart of Engine and Continuation of Thrusting Sequence</p>	<p>1 SPS ROUGH ECO light will go OFF when FCSM CIRCULARITY is reset. The SPS THRUST SW in DIRECT ON Position also overrides the FCSM Monitors.</p> <p>2 If in C/W ΔV, automatic restart of the engine will occur if &lt; 3-4 sec has elapsed since shut-down. If &gt; 4 sec, V50N11 will flash and ENTR must be pushed within TED sec for automatic restart</p> <p>3 SPS ROUGH ECO light is reset when ΔV THRUST-A and B switches are OFF</p> <p>4 SPS is fully operable but ROUGH ECO light will remain ON for duration of mission.</p> <p>5 SPS operable but FCSM may terminate subsequent burns</p> <p>6 SPS operability dependent upon subsequent investigation</p>
<p>3 SPS FLANGE TEMP HI</p> <p>YELLOW</p> <p>Light ON if: Injector/chamber Flange temp. is ≥ 480°F</p>	<p>1 BURN MISSION CRITICAL?</p> <p>YES → 2 CONTINUE BURN</p> <p>NO → 3 IF THRUSTING ΔV THRUST A (B) - OFF</p> <p>4 MSFN FLANGE TEMP READOUT?</p> <p>BOTH NORMAL → 5 C/W FAILURE</p> <p>BOTH HIGH → 6 EXCESS FLANGE TEMP</p> <p>ONE HIGH ONE NORMAL → 7 EXCESS FLANGE HEATING OR INSTRUMENTATION FAILURE</p>	<p>1 High Flange temp may occur up to TED min following a burn from normal heat soak-back</p> <p>2 Flange burn through, may be expected at anytime, possibly resulting in chamber separation</p> <p>3 MSFN Can Confirm Flange temperature over 480°F</p>

G&N MALFUNCTION

SCS MALFUNCTION

SPS MALFUNCTION

RCS MALFUNCTION

EPS MALFUNCTION

T/C MALFUNCTION

ECS MALFUNCTION

SEQ MALFUNCTION

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# APOLLO OPERATIONS HANDBOOK

SYMPTOM	PROCEDURE	REMARKS
4 No PRPLNT TEMP CONTROL	<p>1 SPS PRPLNT TK TEMP?</p> <p>LOW AND DECREASING → 2 •SYS TEST(2)- 5A SPS OXID LINE TEMP TEMP LOW?</p> <p>NO → 3 INSTRUMENTATION FAILURE</p> <p>HIGH AND DECREASING INCREASING → 4 •SYS TEST(2)- 5A SPS OXID LINE TEMP TEMP HIGH?</p> <p>YES → 5 SPS LINE HTES FAILED ON</p> <p>NO → 8 INSTRUMENTATION FAILURE</p> <p>9 •CB SPS HTES GAUGING (2)- OPEN</p> <p>6 •SPS LINE HTES-A/B TEMP INCR?</p> <p>YES → 7 SPS LINE HTES A INSUFFICIENT OR FAILED OFF</p> <p>NO → 10 SPS LINE HTES A &amp; A/B FAILED OFF</p>	<p>① Use OXID line temp for SPS PRPLNT temp</p> <p>② SPS HTES/GAUGING Circuit Breakers should be closed before SPS Engine operation</p> <p>③ Propellant temp may be increased by SC orientation or by firing SPS Engine</p>
5 NO RESPONSE OF OXID FLOW VLV TB DURING FLOW ADJUST  (OXID FLOW VLV) PRIM-PRIM	<p>1 •OXID FLOW VLV PRIM-SEC •OXID FLOW VLV INCR-INCR (DECR) OXID FLOW VLV TB CORRECT?</p> <p>YES → 2 PRIMARY OXID FLOW VLV FAILED</p> <p>NO → 3 PRIMARY AND SECONDARY OXID FLOW VLV FAILED</p> <p>3 OXID FLOW TB FAILED → 4 •OXID FLOW VLV PRIM-PRIM •OXID FLOW VLV INCR- (RESISTORS)</p>	<p>① Switch position as required to adjust desired flow rate. Valve cannot be operated unless Power is applied through THRUST ON signal or through SPS QTY TEST sw. If flow valve position was changed by SPS QTY TEST sw, Fuel and oxid quantity readouts must be returned to original values</p> <p>② Secondary valve has sufficient range to compensate for primary valve failure in any direction and still provide valve openings for INCR, NORM or DECR oxid flow</p>
6 SPS QTY %OXID-%FUEL IND READOUT ABNORMAL	<p>1 •PUG MODE-AUX %FUEL-%OXID READOUT NORMAL?</p> <p>YES → 2 •PUG MODE-PRIM •PERFORM QTY TEST PUGS READOUT REACTS NORMALLY?</p> <p>YES → 3 CAPACITANCE PROBE FAILED</p> <p>NO → 4 PRIMARY SYSTEM SERVO AMP FAILED → 5 USE AUX SYS •PUG MODE-AUX</p> <p>6 •PERFORM AUX QTY TEST PUGS READOUT BEHAVES NORMAL?</p> <p>YES → 2</p> <p>NO → 7 DISPLAY FAILED</p>	<p>① Assumes SC is still thrusting. If thrusting terminated before step 1 is complete, proceed to step 6.</p> <p>② Complete thrusting prior to QTY TEST <i>(ANY TEST-100% NOT AT LATER, SCORE) to low checked</i></p> <p>③ MSFN must now supply any propellant quantity data</p>

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# APOLLO OPERATIONS HANDBOOK

SYMPTOM	PROCEDURE	REMARKS
<p>7 SPS QTY OXID UNBAL and ERRATIC OR PEGGED</p>	<p>① PLUG MODE - AUX OXID UNBAL and NORMAL?</p> <p>YES → ② PRIMARY UNBALANCE SYSTEM FAILED</p> <p>NO → ③ PERFORM AUX QTY TEST OXID UNBAL and NORMAL?</p> <p>YES → ④ PRIMARY <del>AUX</del> UNBALANCE SYSTEM FAILED</p> <p>NO → ⑤ <del>SPS QTY</del> OXID UNBAL and FAILED</p> <p>Return to Abnorm Plug Mode</p> <ul style="list-style-type: none"> <li>• Plug Mode - PRIM</li> <li>• Perform Prim QTY Test</li> <li>• Plug Mode - NORM</li> </ul>	<p>① Assumes SC is still thrusting. If thrust has terminated proceed with step ②.</p> <p>② If thrusting terminated before step ① was completed, the AUX Sensing system can be checked during the next SPS turn.</p> <p>③ Activation of SPS QTY TEST switch will realign digital display to Primary systems.</p>
<p>8 HELIUM TANK PRESSURE LOW OR DECREASING</p>	<p>① MSFN VERIFIES SPS He TANK PRESS LOW OR DECREASING?</p> <p>YES → ② LEAK IN HELIUM SUPPLY</p> <p>NO → ③ HELIUM INSTRUMENTATION FAILURE</p>	<p>① MSFN will monitor redundant Helium Pressure instrumentation</p> <p>② Helium depletion imminent</p> <p>③ SPS Engine operable until P reaches TED or until Engine indications require shutdown</p>
<p>9 SPS He VLV Abnormal</p>	<p>① SC THRUSTING?</p> <p>YES → ② SPS He VLV 1 (2) - ON tb's gray?</p> <p>NO → ⑤ SPS He VLV 1 (2) - OFF tb's bp?</p> <p>YES → ⑥ He ALTO MODE MALFUNCTION</p> <p>NO → ⑦ tb or ONE He VLV FAILURE</p> <p>③ SPS FUEL &amp; OXID PRESS DECREASING → ④ BOTH He VLVs FAILED CLOSED</p> <p>STEADY → ⑦</p>	<p>① SPS Engine operable until P reaches TED or until Engine indications require shutdown</p>

*Sensing system failure (prim & aux) would show up and be handled in procedure 6*

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G&N  
MALFUNCTION

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# APOLLO OPERATIONS HANDBOOK

SYMPTOM	PROCEDURE	REMARKS
<p>10. SWB GIVE 11. SWB GIVE 12. SWB GIVE 13. SWB GIVE 14. SWB GIVE 15. SWB GIVE 16. SWB GIVE 17. SWB GIVE 18. SWB GIVE 19. SWB GIVE 20. SWB GIVE 21. SWB GIVE 22. SWB GIVE 23. SWB GIVE 24. SWB GIVE 25. SWB GIVE 26. SWB GIVE 27. SWB GIVE 28. SWB GIVE 29. SWB GIVE 30. SWB GIVE 31. SWB GIVE 32. SWB GIVE 33. SWB GIVE 34. SWB GIVE 35. SWB GIVE 36. SWB GIVE 37. SWB GIVE 38. SWB GIVE 39. SWB GIVE 40. SWB GIVE 41. SWB GIVE 42. SWB GIVE 43. SWB GIVE 44. SWB GIVE 45. SWB GIVE 46. SWB GIVE 47. SWB GIVE 48. SWB GIVE 49. SWB GIVE 50. SWB GIVE 51. SWB GIVE 52. SWB GIVE 53. SWB GIVE 54. SWB GIVE 55. SWB GIVE 56. SWB GIVE 57. SWB GIVE 58. SWB GIVE 59. SWB GIVE 60. SWB GIVE 61. SWB GIVE 62. SWB GIVE 63. SWB GIVE 64. SWB GIVE 65. SWB GIVE 66. SWB GIVE 67. SWB GIVE 68. SWB GIVE 69. SWB GIVE 70. SWB GIVE 71. SWB GIVE 72. SWB GIVE 73. SWB GIVE 74. SWB GIVE 75. SWB GIVE 76. SWB GIVE 77. SWB GIVE 78. SWB GIVE 79. SWB GIVE 80. SWB GIVE 81. SWB GIVE 82. SWB GIVE 83. SWB GIVE 84. SWB GIVE 85. SWB GIVE 86. SWB GIVE 87. SWB GIVE 88. SWB GIVE 89. SWB GIVE 90. SWB GIVE 91. SWB GIVE 92. SWB GIVE 93. SWB GIVE 94. SWB GIVE 95. SWB GIVE 96. SWB GIVE 97. SWB GIVE 98. SWB GIVE 99. SWB GIVE 100. SWB GIVE</p>	<p>1. SWB GIVE 2. SWB GIVE 3. SWB GIVE 4. SWB GIVE 5. SWB GIVE 6. SWB GIVE 7. SWB GIVE 8. SWB GIVE 9. SWB GIVE 10. SWB GIVE 11. SWB GIVE 12. SWB GIVE 13. SWB GIVE 14. SWB GIVE 15. SWB GIVE 16. SWB GIVE 17. SWB GIVE 18. SWB GIVE 19. SWB GIVE 20. SWB GIVE 21. SWB GIVE 22. SWB GIVE 23. SWB GIVE 24. SWB GIVE 25. SWB GIVE 26. SWB GIVE 27. SWB GIVE 28. SWB GIVE 29. SWB GIVE 30. SWB GIVE 31. SWB GIVE 32. SWB GIVE 33. SWB GIVE 34. SWB GIVE 35. SWB GIVE 36. SWB GIVE 37. SWB GIVE 38. SWB GIVE 39. SWB GIVE 40. SWB GIVE 41. SWB GIVE 42. SWB GIVE 43. SWB GIVE 44. SWB GIVE 45. SWB GIVE 46. SWB GIVE 47. SWB GIVE 48. SWB GIVE 49. SWB GIVE 50. SWB GIVE 51. SWB GIVE 52. SWB GIVE 53. SWB GIVE 54. SWB GIVE 55. SWB GIVE 56. SWB GIVE 57. SWB GIVE 58. SWB GIVE 59. SWB GIVE 60. SWB GIVE 61. SWB GIVE 62. SWB GIVE 63. SWB GIVE 64. SWB GIVE 65. SWB GIVE 66. SWB GIVE 67. SWB GIVE 68. SWB GIVE 69. SWB GIVE 70. SWB GIVE 71. SWB GIVE 72. SWB GIVE 73. SWB GIVE 74. SWB GIVE 75. SWB GIVE 76. SWB GIVE 77. SWB GIVE 78. SWB GIVE 79. SWB GIVE 80. SWB GIVE 81. SWB GIVE 82. SWB GIVE 83. SWB GIVE 84. SWB GIVE 85. SWB GIVE 86. SWB GIVE 87. SWB GIVE 88. SWB GIVE 89. SWB GIVE 90. SWB GIVE 91. SWB GIVE 92. SWB GIVE 93. SWB GIVE 94. SWB GIVE 95. SWB GIVE 96. SWB GIVE 97. SWB GIVE 98. SWB GIVE 99. SWB GIVE 100. SWB GIVE</p>	<p>① SPS fully capable on redundant bank if one bank failed</p>

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# APOLLO OPERATIONS HANDBOOK

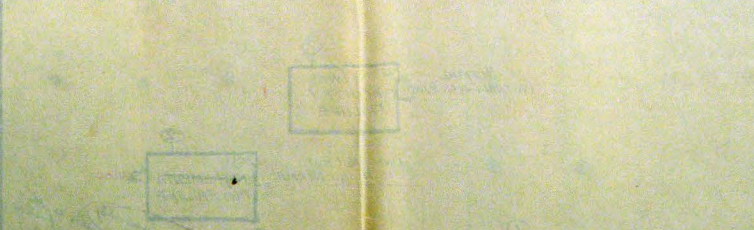
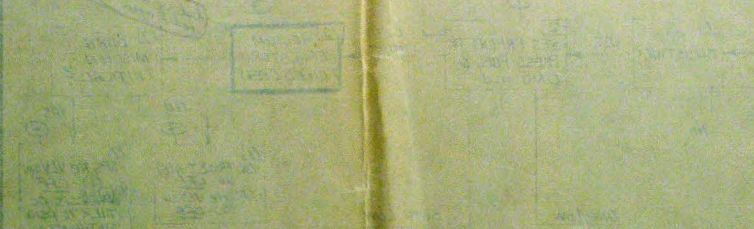


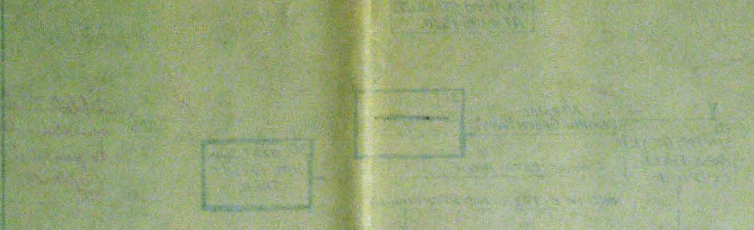


SYMPTOM	PROCEDURE	REMARKS
<p>1. SPS PRESS</p> <p>Light on if SPS FUEL OR OXID TR PRESS IS &gt;200 OR &lt;157 PSIA.</p>	<p>1 SC THRUSTING?</p> <p>YES → 2 SPS PRELNT TK PRESS-FUEL &amp; OXID IND</p> <p>NO → 16 HELIUM REGULATOR FAILED OPEN</p> <p>21 C/W CIRCUITRY FAILURE</p> <p>26 INSTRUMENTATION FAILURE</p> <p>17 BURN MISSION CRITICAL?</p> <p>18 ΔV THRUST A(B) SW OFF</p> <p>19 SPS He VLV SW (2) OFF</p> <p>20 ΔV THRUST SW (2) OFF</p> <p>22 SPS PRELNT TK PRESS-FUEL &amp; OXID IND</p> <p>23 AT ENGINE SHUTDOWN?</p> <p>24 COLD SLAK IF PRELNT TANKS</p> <p>25 CLOGGED OR LEAKING HELIUM SYS</p> <p>26 SPS He VLV SW (2) ON UNTIL PRELNT TK PRESS FUEL &amp; OXID IND STABILIZES AT 195 PSIA</p> <p>27 SYSTEM OPERABLE WITH MANUAL PRESSURIZATION</p> <p>28 SYSTEM OPERABLE UNTIL SPS PC INDICATION DECAYS TO &lt;70 PSIA</p>	<p>① Normal operating Pressure is 170-195 psia. MSFN will use FUEL and OXID to determine pressure data to backup onboard Pressure indication</p> <p>② SPS fully operable.</p> <p>③ SPS Helium Valve Switches must remain OFF for duration of mission.</p> <p>④ If ΔV THRUST SWITCHES OFF prior to SPS PC indication of &lt;70 psia, more burning may be accomplished, but SPS He VLV switches must remain OFF. ΔV THRUST SW switches OFF when SPS PC indication decays to &lt;16 psia. Block I started this was 20 sec of engine burn from velocity probe system. He valves shut off before.</p> <p>⑤ SPS operable with manual Pressurization during burns.</p> <p>⑥ Further operation of SPS may be highly hazardous due to possibility of Propellant leakage.</p> <p>⑦ SPS operable per step 9</p> <p>⑧ Manually repressurize prior to each burn.</p> <p>⑨ Burnet disk ruptures at 219. Relief valve releases at 230 pressure at 208</p> <p>⑩ In block I we could further operation dangerous due to possibility of a tank rupture.</p>

G&N	MALFUNCTION
SCS	MALFUNCTION
SPS	MALFUNCTION
RCS	MALFUNCTION
EPS	MALFUNCTION
T/C	MALFUNCTION
ECS	MALFUNCTION
SEQ	MALFUNCTION



SPS - 4 copy

ABOLIO OPERATIONS HANDBOOK

SYMPTOM	PROCEDURE	REMARKS
D		<p>1. Check for... 2. Check for... 3. Check for... 4. Check for... 5. Check for... 6. Check for... 7. Check for... 8. Check for... 9. Check for... 10. Check for...</p>
E		<p>1. Check for... 2. Check for... 3. Check for... 4. Check for... 5. Check for... 6. Check for... 7. Check for... 8. Check for... 9. Check for... 10. Check for...</p>
F		<p>1. Check for... 2. Check for... 3. Check for... 4. Check for... 5. Check for... 6. Check for... 7. Check for... 8. Check for... 9. Check for... 10. Check for...</p>
G		<p>1. Check for... 2. Check for... 3. Check for... 4. Check for... 5. Check for... 6. Check for... 7. Check for... 8. Check for... 9. Check for... 10. Check for...</p>
H		<p>1. Check for... 2. Check for... 3. Check for... 4. Check for... 5. Check for... 6. Check for... 7. Check for... 8. Check for... 9. Check for... 10. Check for...</p>
I		<p>1. Check for... 2. Check for... 3. Check for... 4. Check for... 5. Check for... 6. Check for... 7. Check for... 8. Check for... 9. Check for... 10. Check for...</p>
J		<p>1. Check for... 2. Check for... 3. Check for... 4. Check for... 5. Check for... 6. Check for... 7. Check for... 8. Check for... 9. Check for... 10. Check for...</p>



SYMPTOM	PROCEDURE	REMARKS
5 SPS QTY %OXID-%FUEL Ind READOUT ABNORMAL	<p>1. PUG MODE SW-PRIM</p> <p>2. SPS QTY-TEST SW-1 FOR 10 SECONDS</p> <p>3. SPS QTY ind</p> <p>READING?</p> <p>CORRECT → 2. PRIMARY GAUGING PROBE FAILED</p> <p>RANDOM → 3. PUG MODE SW-AUX</p> <p>4. SPS QTY-TEST SW-1 FOR 10 SECONDS, THEN 2 FOR 10 SE</p> <p>5. SPS QTY ind</p> <p>READING?</p> <p>CORRECT → 4. CONTINUE IN AUX MODE</p> <p>RANDOM → 5. DISPLAY FAILED</p>	<p>1. Complete any thrusting activity prior to check of Quantity readout.</p> <p>2. In the TEST MODE the display will not move for the first 4.5 seconds. Next it will race for approximately 1 second, and then will roll steadily at 2 to 4 digits per second. If display reacts as above after Primary System failure, then failure is in a tank Probe. If tank Probe is not failed, then random or <u>beige</u> readings will be displayed.</p> <p>3. Telemetry will provide total quantities from auxiliary system, and sum tank quantities from Primary system.</p> <p>4. MSFN must now supply any Propellant Quantity data.</p>
6 SPS QTY CYCL UNBAL IND ERRATIC OR FLEGGED	<p>1. PUG MODE SW-AUX</p> <p>2. SPS QTY-TEST SW-1 for 10 seconds and monitor CYCL UNBAL ind</p> <p>3. SPS QTY-TEST SW-2 for 10 seconds and monitor CYCL UNBAL ind</p> <p>READING?</p> <p>BEIGE → 2. SPS QTY CYCL UNBAL ind FAILED</p> <p>NORMAL → 3. PRIMARY LINEALANCE FAILED</p> <p>4. PUG MODE SW-PRIM</p> <p>5. SPS QTY-TEST SW-1 FOR 10 SECONDS THEN 2 FOR 10 SECONDS</p> <p>6. PUG MODE SW-NORM</p>	<p>1. Complete any thrusting activity prior to checking UNBAL ind.</p> <p>2. Use AUX MODE for operation of Quantity Gauging System.</p> <p>3. Actuation of SPS QTY-TEST switch here will realign digital display to PRIM system.</p>
7 LOSS OF HELIUM TANK PRESSURE	<p>1. MONITOR SPS PRPLNT TK-PRESS He ind</p> <p>MSFN He Press?</p> <p>LOW → 2. MSFN GAIN IS LOSS OF He PRESSURE</p> <p>NORM → 3. MSFN DATA NORMAL</p> <p>4. LEAK IN HELIUM SUPPLY</p> <p>5. He INSTRUMENTATION FAILURE</p>	<p>1. MSFN will monitor redundant helium Pressure instrumentation.</p> <p>2. Helium depletion imminent.</p>
8 SPS He VLV TB INDICATION ABNORMAL	<p>1. MONITOR SPS He VLV TB (2)</p> <p>ONE (BOTH) TB tion Gray Non-BURN → 2. CIRCUITRY OR VALVE FAILED OPEN</p> <p>ONE TB BP DURING BURN → 3. CIRCUITRY OR VALVE FAILED CLOSED</p> <p>TWO TB BP DURING BURN → 4. CIRCUITRY OR VALVES FAILED CLOSED</p> <p>5. ATTEMPT MINIMAL OPERATION OF VALVE</p> <p>6. SPS He VLV SW (2) - ON</p> <p>7. IF TB STILL BP MONITOR SPS PRPLNT TK PRESS FUEL ind. IF PRESS DECAYS FROM REMAINING, MAINTAIN SPS Pz ind. TERMINATE FIRING WHEN SPS Pz is &lt; 70 PSIA</p> <p>8. IF TB STILL BP TERMINATE FIRING</p> <p>MISSILE CRITICAL</p> <p>NON-MISSILE CRITICAL</p>	<p>1. SPS OPERABLE, but propellant Tank Pressures may be slightly higher than normal.</p> <p>2. SPS OPERABLE with one Helium Isolation Valve and Regulatory bank only, unless manual override is successful.</p> <p>3. If Manual override is successful, SPS is operable. Helium Valves must be manually opened at THRUST ON and closed at THRUST OFF.</p>

what is this?  
should it be  
"of unbalance"?

symbology  
MSFN has separate  
He Press. sensor

same sounding

here? switch should be  
off - non burn  
during burn can turn  
switch from auto  
to on

G&N  
MALFUNCTION  
SCS  
MALFUNCTION  
SPS  
MALFUNCTION  
RCS  
MALFUNCTION  
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# APOLLO OPERATIONS HANDBOOK

SYMPTOM	PROCEDURE	REMARKS
<p>1</p> <p>SPS FLANGE TEMP HI</p> <p>YELLOW</p> <p>Light on if Injector/chamber flange temp is <math>\geq 480^{\circ}\text{F}</math></p>	<p>1 BURN MISSION CRITICAL?</p> <p>YES 2 CONTINUE BURN</p> <p>NO 3 IF THRUSTING AT THRUST-A (B) SW OFF</p> <p>4 EXCESS FLANGE HEATING OR INSTRUMENTATION FAILURE</p>	<p>1) Flange burn through may be expected at anytime. Possibly resulting in Chamber Separation. Maximum Temperature should occur after Shut-down.</p> <p>2) MSFN Can Confirm Flange temperature over <math>480^{\circ}\text{F}</math>. Loss of entire chamber. Very possible upon re-fitting of SPS.</p>
<p>2</p> <p>PREPNT HTKS FAIL TO RAISE PREPNT TEMPERATURE</p>	<p>1 SPS-LINE HTKS SW ALB</p> <p>SPS PREPNT TK-TEMP IND</p> <p>TEMP INCREASES?</p> <p>YES 2 SYSTEM A HEATING INEFFICIENT OR FAILED OFF</p> <p>NO 3 DUAL HTKS SYS FAILED, SWITCH, OR INSTRUMENTATION FAILED</p>	<p>1) In the A Position, the 12 electrical strip heaters receive 28V, in ALB position an additional 12 heaters receive 28V.</p> <p>2) Normal operating temperature is <math>+45</math> to <math>+55^{\circ}\text{F}</math>. Redline is <math>+27</math> and <math>+100^{\circ}\text{F}</math>.</p> <p>3) Double Heater operation is required for temperature control.</p> <p>4) If ALB does not maintain temperature above <math>45^{\circ}\text{F}</math>, attitude constraints must be observed or SPS may become non-operational. SPS not operable if fuel temperature is <math>\leq 25^{\circ}\text{F}</math>.</p>
<p>3</p> <p>SPS PREPNT TK-TEMP IND READING ABNORMAL</p>	<p>1 SYS TEST sel (A) SA</p> <p>USE SYS TEST IND FOR HEATER CONTROL</p> <p>2 MSFN CAN PROVIDE BACKUP BY MONITORING PREPNT TEMP</p> <p>IF TLM FUEL TEMP NORMAL</p> <p>3 MSFN MUST MONITOR OXID TEMP AND PROVIDE BACKUP TO CHECK FOR SPS-LINE HTKS SWITCH CONTROL</p>	<p>1) Normal operating temperature is <math>+45</math> to <math>+53^{\circ}\text{F}</math>. This is equivalent to 1.1-1.3 vdc on SYSTEM TEST IND.</p> <p>2) SPS LINE HTKS SW - ON at <math>+45</math> and OFF when <math>+55^{\circ}\text{F}</math>. Heaters must also be ON if any OXID line temperatures is <math>\leq 20^{\circ}\text{F}</math>, and if any fuel line or valve body temperatures are <math>\leq 25^{\circ}\text{F}</math>.</p>
<p>4</p> <p>NO RESPONSE OF OXID FLOW VLV TO DURING FLOW ADJUST.</p> <p>(SPS QTY-OXID FLOW VLV-PRIM SW - PRIM)</p>	<p>1 SPS QTY-OXID FLOW VLV-PRIM SW - SEC</p> <p>SPS QTY-OXID FLOW VLV-INCR SW - INCR (DECR)</p> <p>FLOW VLV TO RESPONSE CORRECT</p> <p>2 PRIMARY OXID FLOW VALVE FAILED</p>	<p>1) Switch Action as required to adjust desired flow rate. Valve cannot be operated unless power is applied through THRUST ON Signal or through SPS QTY-TEST SW.</p>

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MALFUNCTION

SEQ  
MALFUNCTION

Where are problems  
a) SPS PU Sens Light  
b) SPS Range ECU Light  
c) Pils or fuel Limit Light  
d) Abnormal

There are 2 separate flange temp sensors - we should be checking with MSFN - SPS may be unable for a critical burn.

What are normal proc here? check list has temp tank temp  $\leq 45^{\circ}$   $\leq 35^{\circ}$  off

entered do me get these?

This needs rewriting.

What about readings in this column?

measures OX Eng fuel line temp

reads temp (OX & fuel) before heaters

need correlated temps

after nonresponse is noted, burn will probably be over. SPS QTY test switch can be used to verify when Valve failure. select secondary.

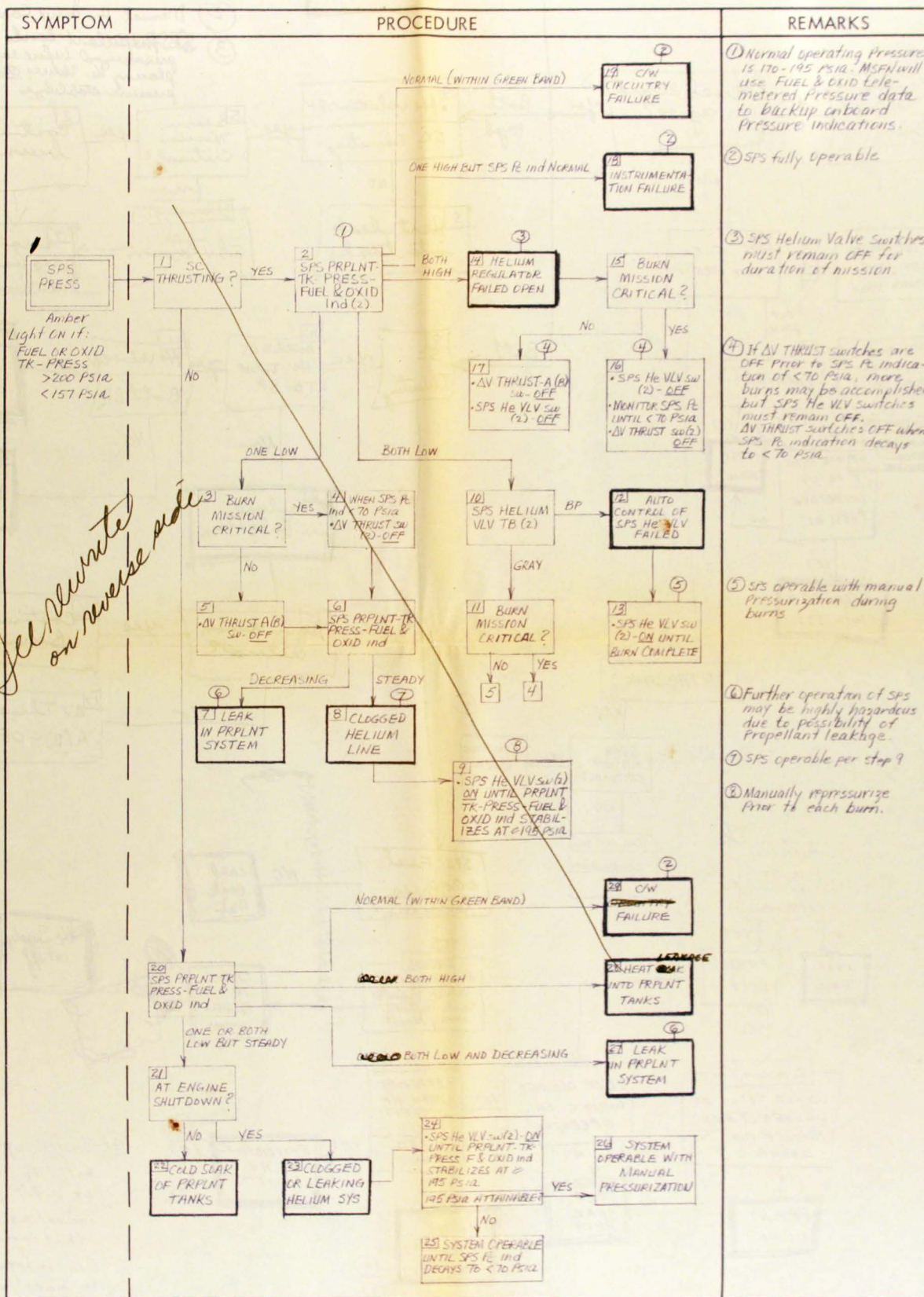
some rewriting needed

slow determination of a failure appears too quick for me!



60a

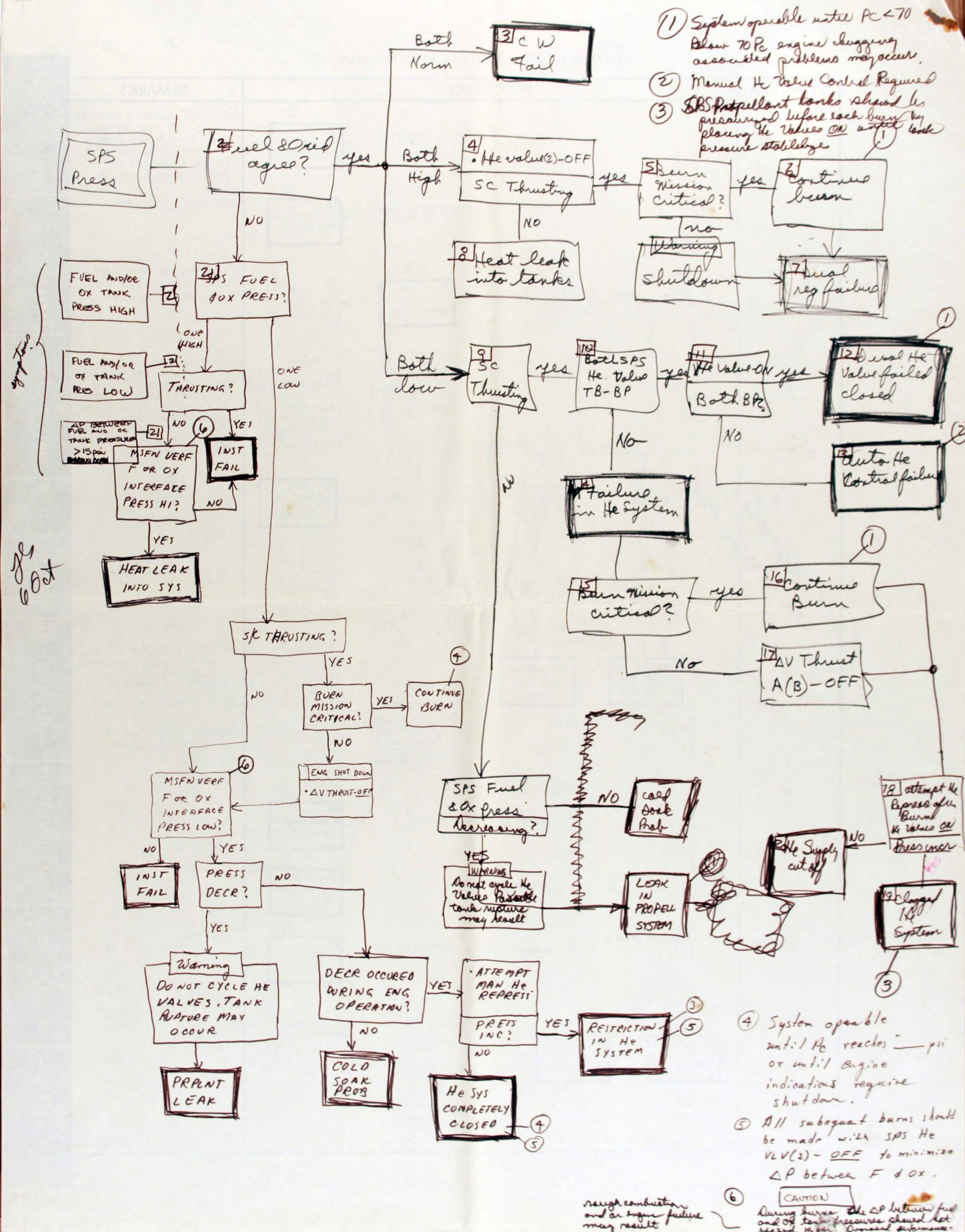
# APOLLO OPERATIONS HANDBOOK



*See reunit on reverse side*

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SEQ MALFUNCTION







# APOLLO OPERATIONS HANDBOOK

SYMPTOM	PROCEDURE	REMARKS
<p><b>2</b></p> <p>SPS ROUGH ECO</p> <p>Amber Light ON if: Vibration level of 180g's Peak-to-Peak for 70-20 msec. or 360g's peak-to-peak for 30-70 msec.</p> <p>CEW FAIL</p>	<p>1. BURN MISSION CRITICAL?</p> <p>YES → 2. FCSM-SPS <del>AND</del> SW- RESET/OVERRIDE</p> <p>NO → 4. ΔV THRUST-A (B) SW-OFF</p> <p>3. +X Thrust (when in direct relay) or THRUST ON PB-Push</p> <p>4. RESET/OVERRIDE has restarted engine. Interruption of engine ON command occurs during switching transient</p> <p>5. SPS ROUGH ECO ON?</p> <p>NO → 6. TRANSIENT VIBRATION LEVEL SENSED IN SPS ENGINE</p> <p>YES → 7. EXCESSIVE ENGINE VIBRATION DUE TO COMBUSTION INSTABILITY</p> <p>8. FCSM-SPS <del>AND</del> SW- RESET/OVERRIDE</p> <p>9. +X Thrust (when in direct relay) or THRUST ON PB-Push</p> <p>10. Automatic restart of engine and continuation of thrusting sequence</p> <p>11. CONTINUE NORMAL PROCEDURES</p> <p>12. Pass Combustion Instability as Outstream Failure</p> <p>13. SPS Combustion Instability</p> <p>14. TERMINATE UPLAGE</p> <p>15. CHECK FOR EXCESSIVE VIBRATION DUE TO COMBUSTION INSTABILITY</p> <p>16. MSPJ VERIFIES PC ABNORMAL?</p>	<p>① SPS ROUGH ECO light will go OFF when FCSM circuitry is RESET. The SPS THRUST SW in DIRECT Position also overrides the FCSM monitors.</p> <p>② SPS is operable, but FCSM may terminate subsequent burns.</p> <p>③ If in G/N, automatic restart of the engine will occur if &lt;3-4 seconds has elapsed since shutdown. If &gt;4 seconds, VSCNII will flash and ENTR must be pushed within 10 seconds for automatic restart.</p> <p>④ SPS ROUGH ECO light is reset when ΔV THRUST-A and B switches are OFF.</p> <p>⑤ System fully operable. Rough ECO light will be on for remainder of mission.</p> <p>⑥ SPS operability dependent upon subsequent investigation.</p> <p><i>West - would you want to use direct relay as point of choice provided for this way is shutdown</i></p>

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SYMPTOM	PROCEDURE	REMARKS
<p>1</p> <p>SPS FLANGE TEMP HI</p> <p>YELLOW</p> <p>Light on if Injector/Chamber flange temp is <math>\geq 480^\circ\text{F}</math></p>	<p>1 BURN MISSION CRITICAL?</p> <p>YES → 2 CONTINUE BURN</p> <p>NO → 3 IF THRUSTING &gt; 4 THRUJET-A (8) SW - OFF</p> <p>MSFN FLANGE TEMP REDUCES → BOTH NORMAL → CW FAILURE</p> <p>LESS FLANGE HEATING OR INSTRUMENTATION FAILURE → BOTH HIGH → EXCESSIVE FLANGE TEMP</p>	<p>① Flange burn through may be expected at anytime, possibly resulting in chamber separation. Maximum temperature should occur after shutdown.</p> <p>② MSFN Can Confirm flange temperature over <math>480^\circ\text{F}</math>. Loss of engine chamber VLV possible upon firing of SPS.</p> <p>③ SPS MAY BE USABLE FOR CRITICAL BURN.</p>
<p>2</p> <p>PPPLNT HTRS FAIL TO RAISE PPPLNT TEMPERATURE</p>	<p>1 SPS-LINE HTRS SW ALB</p> <p>SPS PPPLNT TK-TEMP IND</p> <p>TEMP INCREASES?</p> <p>YES → 2 SYSTEM A HEATING INSUFFICIENT OR FAILED OFF</p> <p>NO → 3 DUAL HTRS SYS FAILED, SWITCH OR INSTRUMENTATION FAILED</p>	<p>① In the A Position, the 12 electrical strip heaters receive 28V. In ALB position an additional 12 heaters receive 28V.</p> <p>② Normal operating temperature is <math>+45</math> to <math>+55^\circ\text{F}</math>. Redline is <math>+27</math> and <math>+100^\circ\text{F}</math>.</p> <p>③ Double Heater operation is required for temperature control.</p> <p>④ If ALB does not maintain temperature above <math>45^\circ\text{F}</math>, attitude constraints must be observed or SPS may become non-operational. SPS not operable if fuel temperature is <math>&lt; 25^\circ\text{F}</math>.</p>
<p>3</p> <p>SPS PPPLNT TK-TEMP IND READING ABNORMAL</p>	<p>1 SYS TEST sel (6) SA</p> <p>USE SYS TEST IND FOR HEATER CONTROL</p> <p>2 MSFN CAN PROVIDE BACKUP BY MONITORING PPPLNT TEMP</p> <p>IF TLM FUEL TEMP ABNORMAL → 3 MSFN MUST MONITOR OXID TEMP AND PROVIDE BACKUP TO CHECK FOR SPS-LINE HTRS SWITCH CONTROL</p>	<p>① Normal operating temperature is <math>+45</math> to <math>+55^\circ\text{F}</math>. This is equivalent to 1.1-1.3 vdc on SYSTEM TEST IND.</p> <p>② SPS LINE HTRS SW - ON at <math>&lt; 45^\circ\text{F}</math> and OFF when <math>&gt; 55^\circ\text{F}</math>. Heaters must also be on if any OXID line temperatures is <math>&lt; 20^\circ\text{F}</math>, and if any fuel line or valve body temperatures are <math>&lt; 25^\circ\text{F}</math>.</p>
<p>4</p> <p>NO RESPONSE OF OXID FLOW VLV TS DURING FLOW ADJUT-</p> <p>(SPS QTY-OXID FLOW VLV-PRIM SW - PRIM)</p>	<p>1 SPS QTY-OXID FLOW VLV-PRIM SW - SEC</p> <p>SPS QTY-OXID FLOW VLV-INCR SW - INCR (DECR)</p> <p>FLOW VLV TS RESPONSE CORRECT → 2 PRIMARY OXID FLOW VALVE FAILED</p> <p>PRIMARY AND SEC OXID FLOW VLVS FAILED</p>	<p>① Switch Action as required to adjust desired flow rate. Valve cannot be operated unless power is applied through THRUST ON signal or through SPS QTY-TEST SW.</p> <p>② Secondary Valve has sufficient range to compensate for primary valve failure in any position and still provide valve openings for INCREASE, NORMAL or DECREASE OXID flow.</p>

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# APOLLO OPERATIONS HANDBOOK

SYMPTOM	PROCEDURE	REMARKS
5 SPS QTY %OXID-%FUEL Ind READOUT ABNORMAL	<p>①</p> <p>1. PIG MODE SW-PRIM • SPS QTY-TEST SW-1 FOR 10 SECONDS • SPS QTY Ind READING?</p> <p>NORMAL</p> <p>2. PRIMARY GAUGING PROBE FAILED</p> <p>ABNORMAL</p> <p>3. PIG MODE SW-AUX • SPS QTY-TEST SW-1 FOR 10 SECONDS, THEN 2 FOR 10 SEC • SPS QTY Ind READING?</p> <p>NORMAL</p> <p>4. CONTINUE IN AUX MODE</p> <p>ABNORMAL</p> <p>5. DISPLAY FAILED</p>	<p>① Complete any thrusting activity prior to checking quantity readings.</p> <p>② In the TEST MODE the display will not move for the first 4.5 seconds. Next it will race for approximately 1 second, and then will roll steadily at 2 to 4 digits per second. If display reacts as above after primary system failure, then failure is in a tank probe. If tank probe is not failed, then random or buggy readings will be displayed.</p> <p>③ Telemetry will provide total quantities from auxiliary system, and sump tank quantities from primary system.</p> <p>④ MSFN must now supply any Propellant Quantity data.</p>
6 SPS QTY OXID UNBAL Ind ERRATIC OR PEGGED	<p>①</p> <p>1. PIG MODE SW-AUX • SPS QTY-TEST SW-1 for 10 seconds and monitor OXID UNBAL Ind • SPS QTY-TEST SW-2 for 10 seconds and monitor OXID UNBAL Ind READING?</p> <p>ABNORMAL</p> <p>2. SPS QTY OXID UNBAL Ind FAILED</p> <p>NORMAL</p> <p>3. PRIMARY UNBALANCE FAILED</p> <p>③</p> <p>4. PIG MODE SW-PRIM • SPS QTY-TEST SW-1 FOR 10 SECONDS THEN 2 FOR 10 SECONDS • PIG MODE SW-NORM</p>	<p>① Complete any thrusting activity prior to checking UNBAL Ind.</p> <p>② Use AUX MODE for operation of Quantity Gauging System.</p> <p>③ Actuation of SPS QTY-TEST switch here will realign digital display to PRIM system.</p>
7 LOSS OF HELIUM TANK PRESSURE	<p>①</p> <p>1. MONITOR SPS PROPULTR-PRESS He Ind</p> <p>②</p> <p>2. MSFN CONFIRMS LOSS OF He PRESSURE</p> <p>④</p> <p>4. LEAK IN HELIUM SUPPLY</p> <p>③</p> <p>3. MSFN DATA NORMAL</p> <p>②</p> <p>2. He INSTRUMENTATION FAILURE</p>	<p>① MSFN will monitor redundant helium Pressure instrumentation.</p> <p>② Helium depletion imminent.</p>
8 SPS He VLV TB INDICATION ABNORMAL	<p>①</p> <p>1. MONITOR SPS He VLV TB (2)</p> <p>One TB BP DURING BURN</p> <p>②</p> <p>2. CIRCUITRY OR VALVE FAILED OPEN</p> <p>⑤</p> <p>5. ATTEMPT MANUAL OPERATION OF VALVE</p> <p>③</p> <p>3. CIRCUITRY OR VALVE FAILED CLOSED</p> <p>④</p> <p>4. CIRCUITRY OR VALVES FAILED CLOSED</p> <p>⑥</p> <p>6. SPS He VLV SW (2)-ON</p> <p>⑦</p> <p>7. IF TB STILL BP MONITOR • SPS PROPULTR PRESS FUEL Ind. • IF PRESS DEGRAYS FROM NORMAL, MONITOR SPS P2 Ind. • TERMINATE FIRING WHEN SPS P2 IS &lt; TO PSR</p> <p>⑧</p> <p>8. IF TB STILL BP TERMINATE FIRING</p>	<p>① SPS OPERABLE, but propellant Tank Pressures may be slightly higher than normal.</p> <p>② SPS OPERABLE with one Helium Isolation Valve and Regulator bank only, unless manual override is successful.</p> <p>③ If Manual override is successful, SPS is operable. Helium Valves must be manually opened at THRUST ON and closed at THRUST OFF.</p>

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REMARKS	PROCEDURE	SYMPTOM
<p>1. The patient was seen at the clinic on 10/5/57. He was a 35-year-old male, white, married, and a high school graduate. He had been in the U.S. Army for 10 years and was currently a sergeant. He had been in the U.S. Army for 10 years and was currently a sergeant. He had been in the U.S. Army for 10 years and was currently a sergeant.</p>	<p>2. The patient was seen at the clinic on 10/5/57. He was a 35-year-old male, white, married, and a high school graduate. He had been in the U.S. Army for 10 years and was currently a sergeant. He had been in the U.S. Army for 10 years and was currently a sergeant. He had been in the U.S. Army for 10 years and was currently a sergeant.</p>	<p>3. The patient was seen at the clinic on 10/5/57. He was a 35-year-old male, white, married, and a high school graduate. He had been in the U.S. Army for 10 years and was currently a sergeant. He had been in the U.S. Army for 10 years and was currently a sergeant. He had been in the U.S. Army for 10 years and was currently a sergeant.</p>

SPS  
6 Oct